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(54) Process for separating waste items for recycling

(57) A process is used for separating items from waste and presorted segments of waste comprising a conveying system with a method of presenting items sequentially to one or more devices producing characterizing data for the items, an on-line computer which processes the characterizing data to identify the item, and a take-off system which uses the electronic output from the computer to physically separate the items from the waste stream into homogeneous lots for recycling.

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PROCESS FOR SEPARATING WASTE ITEMS FOR RECYCLING

This invention relates to a process for separating items in waste for recycling.

Waste is produced in large quantities both from industrial processes and households. Many attempts have been made to recycle some of this waste. This is because the starting material is available at low cost, and sometimes waste authorities even pay to have the waste taken away because otherwise they have to provide expensive landfill sites or incineration facilities. Another reason encouraging the reuse of waste is that many of its components are high energy content products including paper and glass, or plastics made from oil which is a non-renewable resource. Both the UK Government and the European Commission have sponsored work on waste separation and recycling and this activity is well represented in many patents, where many processes for the separation of paper, plastics, and metalic components are claimed.

None of these recycling methods appear to have resulted in economically viable separation methods, and with few exceptions recovery of resources from waste is limited to incineratiion to produce energy in one form or another. Generally the reason why the present methods fail is that they do not sort well enough to produce a product that is pure enough to be useful. Small quantities of impurities in recovered paper or plastics can reduce the value of the product considerably. Plastics in particular must be sorted into specific compatible types or the properties of the resultant product are very poor and its uses limited to low value applications. A simple example is that there are plastic bottles made from PVC, LDPE, HDPE, and PET in household waste, which when separated into homogeneous lots can be recycled to make valuable products. If however the sorting process gathers all these types of plastic bottles together and this mixture is recovered it gives very poor properties due to the fact that the different types of plastic are incompatible.

This failure of present methods explains why efforts have been made to presort waste. For example paper, glass bottles, and aluminium cans are kept separate by the users, and either delivered to special sites or collected as segregated waste. This improves the quality of the starting material, so that the recycled material is purer and has greater value, and has resulted in large quantities of paper and glass being recycled in some countries. However for some components there is difficulty even with these presorted waste streams, because small amounts of visibly similar products contaminate and ruin the properties of the final recovered product.

To continue the previous example, if plastic bottles are presorted and collected, the different types are difficult for the average user to identify but they must be separated if good properties are to be obtained from the recovered plastic.

We have discovered that the solution to all of these problems, with waste in general and presorted waste streams, is to use one or more methods of positively identifying the type of each item sequentially and to use this information to mechanically separate the items into homogeneous lots of compatible items for recycling.

According to the present invention a process is used for separating waste items comprising a conveying/measuring system for presentation of the items sequentially to one or more methods of producing characterizing data for the items, an on-line computer which processes the characterizing data to identify the item, and a take-off system which uses the output from the computer to physically separate the items from the waste stream into homogeneous lots.

A specific embodiment of the invention is one where the conveyor is a conveyor belt on which the waste is spread, the measuring device is a camera which identifies the objects in the waste on the belt and sends data on the size, shape, patterns and lettering, and colour to the on-line computer, which uses the data to control a robot which extracts the desired object from the mixed waste stream, placing it in a skip along with similar items for recycling.

The conveying system will depend upon the particular stream being separated. Specific embodiments include continuous conveyor belts, and belts where the items are held in a predetermined way so that the characterizing system can work better, for example bottles will be arranged on their bases with any label facing the camera and the non labelled part exposed to other devices which need to operate on the plastic itself.

The methods of characterizing the items will include one or more of the following.

The item is viewed by a camera which produces data characterizing the shape, pattern and lettering, size and colour of the item. This can be done on the whole waste stream, or on presorted segments. When the items have been presorted they can preferably be arranged in an optimum way for the camera to obtain the most information when viewing the items.

Spectrophotometers are used to identify the items. All objects absorb or reflect radiation in ways which are characteristic of their inherent structure and thickness. A whole range of radiation is used including visible light, infra-red, ultra-violet, X-rays, gamma rays, and alpha rays, and the type or types chosen will depend upon the specific materials which are being separated. When the radiation is absorbed during transmission through the items a detector determines the characteristics of the resultant radiation and passes this information to the computer. Similarly when radiation is reflected or backscattered from the items it is again detected and characterized to identify the item. For both methods the item is preferably held in a pre-arranged configuration with respect to both the radiation source and the detector as this will optimize the accuracy of the identification.

Another method of producing characterizing data is an ultrasonic gauge. The response of an item to ultrasonic vibration is related to its basic physical properties and thickness. Thus by presenting the item to an ultrasonic probe and measuring the response the item is characterized.

Another method of characterization is to measure one or more of the physical properties of the item. For example a needle or probe will be pushed against the item while it is held rigidly, and the level of penetration and the deflection measured as an electronic response from a transducer is characteristic of the item's softness and stiffness.

A method of producing characterizing data is a reader of information on the item in the form of patterns or symbols, for example bar codes on the items. Many packaging items have a bar code printed on them or on a label, which is used when selling the item. This bar code contains a considerable amount of information about the item, and once read can be valuable in identifying the item quickly. An advantage of this method is that the readers are well developed and readily available. Another advantage is that these readers are designed to read the bar code easily without presenting the item in any particular configuration to the reader. If legislation is introduced which specifies that all packaging items must have bar codes or similar identification so that they can be easily recycled, this would obviously facilitate recycling by this method.

Once one or more characterizing data are produced by these methods, a computer is used to identify the item by processing the data as symbols. When it is found that the materials collected are still not pure enough, a different method or combination of characterizing methods are used until a satisfactory result is obtained.

Process control computers which use data to produce output signals to control processes are well known. Often however the decision about the identity of the items considered in this invention will be difficult because the data is not conclusive, so the preferred embodiment is a computer programmed with a knowledge base of rules and facts which enables it to infer the identity of the item from the characterizing data even when some of this data is conflicting. Also preferred is a method of learning from the success of the sorting process, by using the success rate to improve the rules by feeding quality control data back to the computer which is able to modify its basis for inferring the identity of the item accordingly. One method of doing this is to simulate the neural network in the brain by having a network of linked processors and using this to determine the best strategy for separating the items.

The take-off system consists of a conveyor belt with a series of discharge arms which are electronically activated by the computer to discharge the items into one of a series of boxes or hoppers containing other similar items thus forming homogeneous lots. Alternatively the take-off system consists of a conveyor belt with a robot which is electronically activated by the computer to discharge the items into one of a series of boxes or hoppers containing other similar items thus forming homogeneous lots.

CLAIMS

1 A process for separating items from waste for recycling comprising a conveying/measuring system for presentation of the items sequentially to one or more methods of producing characterizing data for the items, an on-line computer which processes the characterizing data to identify the item, and a take-off system which uses the output from the computer to physically separate the items into homogeneous lots.

2 A process as claimed in Claim 1 wherein the items are industrial waste.

3 A process as claimed in Claim 1 wherein the items are household waste.

4 A process as claimed in Claim 1 wherein the items are a presorted segment from industrial waste.

5 A process as claimed in Claim 1 wherein the items are a presorted segment from household waste.

6 A process as claimed in Claim 1 wherein the items are presorted bottles from household waste.

7 A process as claimed in Claim 1 wherein the items are presorted cans from household waste.

8 A process as claimed in Claim 1 wherein the items are presorted plastic containers from household waste.

9 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor belt with one or more methods of producing characterizing data for each item.

10 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with a robot to present the items to one or more methods of producing characterizing data.

11 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a camera.

12 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a camera which produces data characterizing the shape, pattern and lettering, size and colour of the item.

13 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a source of radiation and a detecting spectrophotometer.

14 A process as claimed in Claim 13 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being an ultra-violet or an infra-red spectaphotometer.

15 A process as claimed in Claim 13 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being an isotope gauge emmitting beta rays or gamma rays.

16 A process as claimed in Claim 13 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a gauge emmitting X-rays.

17 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being an ultra sonic gauge.

18 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a measurement of the physical properties of the item.

19 A process as claimed in Claim 1 wherein the conveying/measuring system is a conveyor with one of the methods of producing characterizing data being a reader of bar codes on the items.

20 A process as claimed in Claim 1 wherein the computer is programmed with a knowledge base of rules and facts which enables it to infer the identity of the item from the characterizing data, and so issue an output signal to the take-off system even when the characterizing data is not absolutely conclusive.

21 A process as claimed in Claim 20 wherein the computer has a knowledge base of rules and facts, which is modified by a feedback system which takes quality control data on the separated lots and introduces this into the computer to constantly improve the inference about the identity of the item by adaptive learning based on the success of the separations.

22 A process as claimed in Claim 1 wherein the computer is a self learning system based on a neural network simulating the interconnections of the human brain.

23 A process as claimed in Claim 1 wherein the take-off system consists of a conveyor belt with a series of discharge arms which are electronically activated by the computer to discharge the items into one of a series of hoppers containing other similar items thus forming homogeneous lots.

24 A process as claimed in Claim 1 wherein the take-off system consists of a conveyor belt with a robot which is electronically activated by the computer to discharge the items into one of a series of hoppers containing other similar items thus forming homogeneous lots.

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